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UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

WORK OF THE UNITED STATES BUREAU OF MINES

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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE -- BUREAU OF MINES

THE WORK OF THE UNITED STATES BUREAU OF MINES[1]

The United States Bureau of Mines frequently receives requests for information regarding the details of its organization and the nature of its activities. In response to such an inquiry a series of articles outlining the work of the bureau as a whole and of its different divisions was prepared and published in the United States Daily, Washington, D. C., during November, 1929. These articles are reprinted here in the hope that they may assist in giving the public a more complete understanding of the aims and purposes of the bureau and the methods by which it is laboring for the attainment of safer conditions and more efficient methods in American mineral industries.

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SAFETY AND EFFICIENCY IN MINING FOSTERED BY FEDERAL SERVICES

Investigations Conducted by Bureau of Mines to Safeguard Health of Workers and to Aid Industry

By Scott Turner,
Director

The United States Bureau of Mines is entrusted with two broad general lines of investigation: The conduct of studies looking toward bringing about safer and more healthful conditions among workers in the mineral industries; and the study of new and improved methods for mining, treatment and utilization of the numerous mineral materials essential to the welfare of mankind.

The mining, quarrying, metallurgical, and oil and gas industries of the Nation give employment to well over 2,000,000 men, who, with their dependents, number some 10,000,000 or 11,000,000 of our citizens, so that it is manifest that the Bureau's investigations designed to improve the working conditions of this great group of citizenry are of a highly important nature.

The Bureau of Mines has no legal authority to compel the adoption of its health and safety recommendations, the regulation of mining operations being generally one of State rather than Federal jurisdiction.

The Bureau's work is of an investigative and educational nature, and it relies upon the cooperation of the various State mining departments and the mining industry to make its findings effective in the betterment of conditions.

The magnitude of the mining industry of the United States is perhaps not generally appreciated by the public. The value of the annual production of the primary mineral industries of the United States, including metallurgical works and oil refining, amounts to approximately $8,300,000,000.

But this figure tells only part of the story. Many other manufacturing industries depend on the mines for their raw materials. The additional values created by the metal-working industries and others fabricating minerals over the cost of raw materials amount to another $8,500,000,000.

Thus the total wealth created annually by the mines and the mineral-using industries amounts to about $17,000,000,000. The raw products of the mines constitute 51 per cent of the revenue-freight tonnage of the Nation's railroads. Manufactures of raw minerals, such as gasoline, iron and steel products, cement, clay products, etc., contribute 14 per cent of the tonnage, so that the mineral industries contribute 65 per cent or approximately two-thirds, of all the revenue-freight tonnage moving over the country's network of railways.

The United States, with but 6 per cent of the world's population, produces 40 per cent of the world's aluminum, 60 per cent of the world's smelter copper, 51 per cent of the pig iron, 45 per cent of the smelter zinc, 39 per cent of the coal, 71 per cent of the petroleum, 38 per cent of the phosphate, and 70 per cent of the world's sulphur. Scores of useful minerals are produced in the United States, and there are very few mineral materials essential to the welfare of humanity that are not found to some extent within our borders.

From the facts above outlined, it will be seen that the Bureau's task of studying ways and means for advancing the technique of the numerous and varied mining and allied industries is no small one.

At the present time, the Bureau is conducting more than 300 investigations, covering a wide variety of problems, all having the general aim of conserving the Nation's irreplaceable mineral resources and bettering the conditions of the army of workers which the mineral industries employ.

The Bureau of Mines was established in the Department of the Interior on July 1, 1910, by act of Congress (36 Stat. 369), and was transferred by Executive Order to the Department of Commerce on July 1, 1925.

For the fiscal year ending June 30, 1930, Congress has appropriated for work to be conducted by the Bureau of Mines the sum of $2,274,670, of which $170,800 is for helium investigations and the procurement of helium for military and naval purposes, and $2,103,870 is for the regular work of the Bureau, such as investigating causes and methods of prevention of mine accidents; operating mine rescue cars and safety stations; investigating mining methods and conditions, the use of explosives and electricity in mines, the testing of fuels, the mining, preparation, treatment and utilization of ores and minerals; also, oil, gas, and oil-shale investigations, maintenance of 11 mining experiment stations, and investigations for improvement of health and sanitation in mining; for studying the economics of mineral industries, operating the Government Fuel Yards, and investigating potash deposits; for salaries of an administrative, clerical, and scientific force, for office facilities, and travel expenses. In addition, $78,000 is provided for issuing publications on the results of the Bureau's work.

As the work of the Bureau falls into four principal classes, (1) administrative, (2) scientific, (3) humanitarian, and (4) economic, it is organized in four branches, centering under the office of the director, as follows: (1) Technologic Branch, (2) Economic Branch, (3) Health and Safety Branch, and (4) Administrative Branch.

The bulk of the Bureau's investigative activities is performed by the Technologic Branch, which includes seven divisions. The Mechanical Division conducts studies dealing with the efficient preparation and use of fuels, and investigates and tests electrical and other mining machinery and equipment.

The Bureau was a pioneer in the study of the fundamentals of fuel combustion and the transmission of heat, and its studies have contributed greatly to knowledge of combustion of coal and to designing of boiler furnaces. The Bureau has conducted tests of hundreds of coals from the different districts to determine their steaming, gas-producing, coking and briquetting qualities.

The testing of electrical appliances submitted voluntarily by manufacturers of mining equipment has resulted in developing an extensive list of mine lamps, coal-mining machines and other mining equipment which is far safer for use in explosive atmospheres than other types of equipment.

The work of the Mining Division relates principally to the development of improvements in mining methods, with the object of reducing loss and waste in mining, and preventing accidents. The investigations of the division include such matters as drilling and blasting, loading of ore and coal, mine timbering, breaking and handling of ore, mine ventilation, underground transportation, mine sampling methods, efficiency of mine labor, and mine costs.

In the effort to develop domestic sources of potash and to make American farmers independent of foreign domination of this essential fertilizer material, the Mining Division is drilling holes in New Mexico and Texas, where beds of potash-bearing salts have been found.

The Explosives Division tests explosives to determine their suitability for use in gassy or dusty coal mines, studies the ingredients of explosives, and investigates the methods of handling, using and storing explosives for mining operations.

Approximately 80 per cent of the total quantity of explosives sold and used in the United States is consumed by the mining and quarrying industries. One of the greatest factors in the campaign for preventing accidents in coal mines is the work of determining permissibility of explosives developed under the guidance of the Bureau.

The Petroleum and Natural Gas Division is studying numerous problems of vital importance to all of the oil and refining operators in the United States. The objective of the Bureau's technologic research on petroleum and natural gas is toward eliminating waste, promoting economic methods of controlling production, and determining better and more efficient ways of manufacturing and utilizing products, with a view of conserving petroleum and natural gas, irreplaceable resources, essential in time of peace and invaluable in time of war.

One problem of the greatest importance is devising new or improved methods of production, whereby more than 20 per cent of the oil in reservoir sands can be recovered. The Bureau has pointed the way toward improvements in drilling methods, especially by the use of mud fluid and cement for the control of underground waters, which have saved billions of cubic feet of natural gas and millions of barrels of oil.

By reducing evaporation losses in storage and pipe-line systems, millions of gallons of gasoline have been saved. The oil and gas industries have their own particular hazards, and the Bureau has extended its safety work to these industries.

WASTES IN MINERAL INDUSTRY REDUCED BY RESEARCH WORK

Refining Processes, Mining Methods, and Distribution Studied by Federal Specialists

By Scott Turner,
Director

The Metallurgical Division of the Bureau of Mines is conducting numerous investigations looking toward the recovery of metals from complex or low-grade ores that otherwise could not be worked profitably.

The Bureau has taken an active part in the technologic progress in the metallurgical industries, and, through its investigative work, constantly seeks to focus the attention of the industry upon wasteful or inefficient practice, to point out improvements, and to obtain the cooperation of producers in adopting better methods and putting into use more efficient devices.

Among the more important studies now under way are the physical chemistry of steel making, the crushing and grinding of ore, flotation fundamentals, reactions in the blast furnace, specific heats and heats of formation of oxides and sulphides, rates of reactions of various metallurgical materials, solubility studies, etc. All of these problems are basic in the industries to which they apply.

The Bureau is working on the development of methods which can be applied to the production of manganese from low-grade domestic deposits. A significant research is the application of methods originally devised for the study of the interior of iron blast furnaces to similar exploration in lead furnaces. Under the provisions of recent legislation, an extensive program of research has been undertaken looking to the commercial utilization of the potash content of polyhalite, leucite, alunite, greensand, and other materials of which the United States has extensive resources.

The Experiment Stations Division controls and coordinates the work of the different stations. The Bureau's largest experiment station, situated at Pittsburgh, is chiefly engaged on investigations relating to coal and coal mining, health of miners, prevention of mine accidents, studies in iron and steel metallurgy, and on helium. Nearby at Bruceton, Pa., is the experimental mine and the explosives-testing station of the Bureau.

The next largest station, at Bartlesville, Okla., is devoted to petroleum; the station at Berkeley, Calif., deals with metallurgical chemistry; at Reno, Nev., with rare and precious metals; at Tucson, Ariz., with low-grade ores, especially copper; at Seattle, Wash., mining and utilization of coals, ores and minerals of the Northwest; at Minneapolis, Minn., with beneficiation and smelting of iron and manganese ores of the Great Lakes Region; at Tuscaloosa, Ala., with coal and iron problems of the South; at Rolla, Mo., with waste in the lead and zinc industries of the Mississippi Valley; at Salt Lake City, Utah, with treatment of low-grade ores of zinc and lead; at New Brunswick, N. J., with production and use of nonmetallic minerals.

The Bureau, through its Helium Division, designed, built, and operates the new helium-production plant at Soncy, near Amarillo, Tex., and also conducts fundamental research in the physics and chemistry of this rare non-inflammable gas useful in the safe operation of dirigibles.

The operation of the new Amarillo helium plant has assured the conservation for the Army and Navy of the only known helium-bearing natural gas field in the world of any magnitude. It is now definitely indicated that helium can be produced by the Bureau, in any quantities required, at a price of less than half the lowest formerly paid by the Government.

The Economics Branch collects and disseminates statistical data regarding the production, distribution, and storage of the numerous essential minerals. The results of these statistical and economic studies are widely used by the mineral industries for keeping in touch with market trends and with the solution of business problems. The Government Fuel Yards purchases and distributes coal at cost to the numerous Government buildings in and near the District of Columbia.

The Coal Division studies industrial and commercial problems of the coal industry. The Division of Mineral Statistics compiles information on production and consumption of minerals and on accidents in the mineral industries.

The Petroleum Economics Division makes statistical and economic studies relating to the petroleum, natural gas, and allied industries, and these data are used widely by the industries in planning operations.

The Rare Metals and Nonmetals Division makes economic studies and disseminates information on a wide variety of mineral industries of the nature indicated in its title. The Common Metals Division includes in its field the economic aspects of copper, lead, zinc, gold, silver, iron, chrome, manganese, nickel, aluminum, tin pyrite, and sulphur.

The Health and Safety Branch includes the Health Division and the Safety Division. The activities of the Health Division include experimental studies on carbon monoxide, approval of gas masks, analysis of mine gases, acid coal-mine drainage, toxic gases and vapors, causes of death among miners, medical organization and industrial hygiene, sanitary surveys of mining camps, and incidence of silicosis and other diseases among miners.

Close cooperation with the Public Health Service and health and accident commissions of various mining and industrial States is leading to improved sanitary, hygienic, and safety conditions in the mining and allied industries.

The Safety Division investigates safety in mining, assists in recovery and rescue work after mine explosions and fires, trains men in rescue methods and first-aid to the injured, and seeks to advance the general movement for greater safety in the mineral industries. Crews of the mine rescue cars and stations maintained by the Bureau have given aid at hundreds of disasters, have helped to save life and property, and have trained more than 365,000 men in first-aid of mine-rescue methods.

The chief value of this work, however, is not so much in the actual saving of life or the training of men as in arousing and maintaining interest in safety. To widen and advance the interest in safety, the Bureau cooperates in the holding of safety contests, gives to mine officials advanced training in first-aid and mine-rescue methods, and is extending its campaign to the petroleum industry.

The Administrative Branch, whose chief function is coordinating the business of the Bureau, embraces: The Division of Office Administration, which includes legal, accounts, property, personnel, mail and files, and multigraphing sections; the Information Division, having the duty of disseminating information obtained as a result of the Bureau's investigations and studies, editing and distributing publications, preparing press reports, and replying to general inquiri on the Bureau's work.

The Bureau has issued, in all, 303 bulletins, 454 technical papers, 36 miners' circulars, numerous miscellaneous printed reports, and more than 1,000 short mimeographed reports. In addition, more than 3,000 brief papers have been issued in technical journals and by cooperative agencies. The annual free distribution of its publications approximates 500,000 copies, and sales, over 75,000. More than 100,000 individual letters of inquiry on mining subjects are answered each year. Its library of educational motion pictures, costing over $1,000,000, has been contributed by the mining industry under plans prepared by Bureau engineers, at small cost to the Government.

In its technologic, economic and safety work, the Bureau cooperates with the War Department, Navy Department, Department of Agriculture, Shipping Board, Public Health Service, the District of Columbia municipal government, and other Federal agencies. It also cooperates with various State governments, universities, technical societies, and civic associations.

It has, of course, been quite impossible in the short space available to give more than the barest outline of the organization of the Bureau of Mines. The work of the different divisions will be given in greater detail in articles that are to follow.

Although the work of the Bureau of Mines bears directly upon the study of the problems of the mineral and allied industries, the results of its investigations have a much more far-reaching effect. The Bureau's fuel investigations have shown definitoly the means of obtaining a greater percentage of power, heat or light from a ton of coal, and this information is, of course, invaluable to the manufacturing and transportation industries and even to every householder.

The Bureau's researches on the physiological effects of mine gases and dusts and its investigations of the atmospheric conditions under which men can labor more efficiently in mines. have given results that are being applied in th Nation's factories and workshops far removed from any mineral district.

The Bureau's studies of better methods of mining, treatment, and utilization of the numerous important nonmetallic minerals, which enter so largely into the construction of buildings, highways and engineering enterprises, have afforded information that leads to better conditions in the life of everyone. The Bureau has, through scientific research, helped to assure abundant motor-gasoline supplies and to reduce the cost of motor fuel.

In a hundred other ways it might be pointed out how the results of the Bureau's work have tended to benefit every citizen. Thus, although the work actually done by the Bureau is restricted to the mineral industries, the results of the work have applications that directly affect the Nation's efficiency and the health and happiness of millions of people.

INFORMATION ON MINING METHODS DISTRIBUTED BY FEDERAL SERVICE

Surveys Are Made of Practices in Industry and Adoption of Better Processes Is Fostered

By C. W. Wright,
Chief Engineer, Mining Division

The Mining Division of the Bureau of Mines is concerned with the problem of bettering conditions in mining. The first essential is to know as well as possible present conditions, and by this is meant the methods employed, in the exploration for mineral deposits, in their development, and in the extraction of ore.

Each mine operator is trying to improve his mining practice and thus reduce costs. Lower costs naturally result in permitting the mining of lower grade ores and in increasing the mineral reserves.

In order to obtain this knowledge of present mining practice and costs throughout the United States, as well as in Canada and Mexico, the Mining Division has selected certain mines in each district that present interesting features.

In order to get the superintendent or engineer in charge of these mines to write a paper describing in detail the results of his operations, he is appointed as a consulting engineer to the Bureau of Mines and is given an outline to aid him in writing his paper. Where time does not permit these engineers to do this work, one of the engineers of the Mining Division is detailed to assist him in preparing the paper for publication.

The mass of detail as to mining practice and costs obtained in these papers forms the basis for separate publications on the various problems in mining, such as methods of mine exploration, methods of sampling and estimating ore reserves, mining methods and costs, underground haulage, underground mine support, mine ventilation, contract and bonus systems, and other minor problems.

All of these problems are being studied, and the final result will be a series of Bureau of Mines publications on each of these subjects which will be a real aid to all metal-mine operators and managers as well as to the mining industry. This work is now being extended to the nonmetallic and coal mines in order that these operators may benefit from improvements in mining practice at the metal mines and vice versa.

This plan of having these papers on mining methods prepared by the mine managers is not only the most satisfactory but the most economical, as it requires only a few Bureau engineers to aid in the work. Their publication in the form of Information Circulars is also the most expedient and economical.

Thus far 25 papers have been issued and 60 are in the course of preparation. The importance of the work is shown by the interest the mining public is taking in these publications, the hearty support by the mining companies, the reprinting of the papers by the various mining journals, and the increasing demand for copies of the papers.

Of future importance both to the mining interests and to the men carrying on research work in the treatment of ores is the supplementary series of papers dealing with milling methods and costs now in course of preparation by many mill superintendents throughout the United States.

A comprehensive outline for papers on milling methods has been prepared by the Mining Division with tables for the presentation of detailed data on results of crushing, grinding, and concentration by gravity, flotation, and leaching processes, as well as tables showing costs and unit supply consumption.

The work of the Mining Division is the gathering of data and details of present mining and milling practice and the dissemination of this data through its information circulars.

The object of this work is to make the Bureau of Mines a clearing house of information for the mining industry, where the mine operator may obtain authentic data on present mining practice in the different districts and for the various types of mineral deposits.

Besides this gathering and publishing of mining data, the Mining Division is carrying out a thorough investigation of the geophysical methods of prospecting and is giving to all interested an abstract each month of the papers published in the United States and foreign countries on this subject, as well as important papers on the results of the field work carried out by the Bureau of Mines parties.

This field work is being done to show the relative value of the different geophysical methods under various conditions and as a guide in the locations of mineral deposits.

The study of ground movements and subsidence at and in the vicinity of mines is another important problem that has been thoroughly investigated in the iron and copper mines of Michigan and is now being carried out at the copper mines of the Southwestern States.

Studies of falls of roof and coal at many of the important coal mines in Pennsylvania, West Virginia and Ohio have been made and confidential reports and recommendations given to the mining companies. These studies are now being extended in the coal mines of the Western States, their object being to aid the operators in lessening the great number of mine accidents due to this cause.

This research work in geophysical prospecting, subsidence, falls of roof, and ventilation has been of particular interest and value to the mine operators, as only men expert in such studies can do the work. These studies are a real aid to the mining companies and have been so recognized by the managements of the properties where the Bureau of Mines engineers have been able to give this technical assistance.

WASTE REDUCED BY IMPROVEMENT IN METHODS OF REFINING MINERALS

Bureau of Mines Develops Processes for Extracting Higher Per Cent of Metal From Ore at Lower Cost

By A. C. Fieldner,
Chief Engineer, Experiment Stations Division

According to Congressional act, one of the principal functions of the Bureau of Mines is to conduct inquiries and scientific and technologic investigations concerning the preparation, treatment, and utilization of mineral substances with a view to increasing efficiency and eliminating waste. The objectives of this act are of fundamental importance to the present and future prosperity of the Nation.

Our present position in the world scale of prosperity is undoubtedly due in large measure to our wealth of mineral resources. These are being used at a high rate and they are not replaceable. Therefore, it is of prime importance that the efficiency of extraction of metals from their ores be increased and the waste in treatment be reduced to the lowest possible amount.

The Metallurgical Division of the Bureau of Mines is concerned with this broad problem. Owing to the magnitude of the field, the work is subdivided into ferrous and nonferrous metallurgy.

This paper describes the work of the Bureau of Mines in nonferrous metallurgy, that is, all the metal ores except iron, which, due to its outstanding importance, will be described in a separate paper.

In order to avoid duplication of work in the Bureau of Mines and the Bureau of Standards it has been agreed that the Bureau of Mines should deal with the mining and preparation of ores and the extraction of the metals from the ores. The Bureau of Standards deals with problems relating to the metals themselves after they have been produced and fabricated into manufactured articles.

Under this arrangement these two important bureaus in the Department of Commerce supplement the work of each other in the field of metallurgy, but in no wise duplicate, even though each bureau has a metallurgical division.

The distribution of the Bureau of Mines experiment stations in various parts of the country in direct contact with the mining and metallurgical industry is of great advantage in conducting research of practical value in cooperation with industry.

The Bureau of Mines has 11 experiment stations located in suitable proximity to the mining regions and the metallurgical industries which they serve. In addition other field offices and stations are operated temporarily until the work in the particular district served is completed.

The Bureau's work in nonferrous metallurgy covers the ore dressing, milling, and extraction of the finished metals of copper, lead, zinc, gold, silver, and manganese, and the less common and rare metals, such as chromium, tungsten, molybdenum, platinum, etc.

Ore dressing research is conducted under the direct supervision of the supervising engineer of the Mississippi Valley Experiment Station, at Rolla, Mo., and includes studies of milling problems in the Tri-State zinc district of Oklahoma, Kansas, and Missouri, milling of southeast Missouri lead ores, beneficiation of the low-grade maganiferous ores of the whole United States, beneficiation of Missouri iron ores, fundamental studies of crushing and grinding, and flotation fundamentals.

Typical of this work is the research in the southeast Missouri lead belt. This region handles 20,000 tons of low-grade ore daily. The low price of lead makes it imperative to obtain high recoveries in as efficient a manner as possible.

By close cooperation between the Bureau and the operators of the district less lead and zinc are lost each year. Changes made last year in accordance with Bureau recommendations result in added recoveries of about $300,000 annually.

Small amounts of manganese are added to steel to make it hard. Our annual consumption of this metal is about 300,000 tons, of which approximately 10 per cent is produced in this country. Hundreds of manganese prospects occur in widely scattered localities throughout the United States, although only a few of them are rich enough to be smelted directly.

The Bureau of Mines has therefore undertaken a study of these deposits at its Mississippi Valley Experiment Station, Rolla, Mo.; the Rare and Precious Metals Experiment Station, Reno, Nev.; and the North Central Experiment Station, Minneapolis, Minn., to find under what methods of treatment the material can be made commercially available. Results to date are very encouraging and show the possibility of converting ores of little value into high-grade products.

Not long ago 10 pounds of metallic copper was wasted for every ton of copper ore mined in the Lake Superior district. The loss entailed in this important district was therefore tremendous.

Research by the Bureau of Mines metallurgists and the hearty cooperation of the operators of the district has reduced this waste to less than two pounds per ton of ore, thus effecting a saving of over 10,000,000 pounds of copper a year.

One of the important first steps in most metallurgical processes is the crushing of the ore as mined to a size suitable for treatment. In most mills this is an empirical step, the material being ground until it is smaller than some certain screen size which is usually rather arbitrarily set.

Realizing that there must be huge wastes in such a method, the Bureau undertook an extensive and thorough study of the fundamentals of crushing and grinding at its Intermountain Experiment Station, Salt Lake City, Utah. It first developed a method for measuring the work performed. Applying this method in a large western mill showed that 45 per cent of the power input of the motor was used in grinding, but that 90 per cent of the power was used in producing material finer than necessary, making a useful efficiency of about 4 per cent. A correction of this waste will reduce milling costs.

In flotation the metallurgist has an extremely valuable tool. By adding certain chemicals to a finely ground ore and then beating the whole into a foam, some minerals will sink to the bottom and others will be caught in the froth which can be removed. The Bureau is engaged in carefully studying at its Intermountain Experiment Station, Salt Lake City, Utah, just which chemicals will best float different minerals in order to be able to efficiently separate the individual minerals from some of our complex western ores.

Hydrometallurgical and smelting studies are under the supervision of an engineer stationed at the Intermountain Experiment Station, Salt Lake City, Utah. These problems include the identification and removal of loss in the milling of precious metals, cyanide recovery of precious metals associated with minor copper values, the recovery of chromium from low-grade ores, the production of manganese from low-grade material by hydrometallurgical means, the recovery of the zinc now lost in zinc ferrites, the study of the conditions for the best operation of the lead blast furnace, the leaching of low-grade copper ores and tailings, the smelting of copper and the determination of fundamental metallurgical constants.

Copper in gold and silver ores has always been regarded as extremely detrimental to their treatment. By the use of methods devised by the Bureau of Mines at its Rare and Precious Metals Experiment Station, Reno, Nev., this impurity need no longer be feared. Many properties now undeveloped or idle can be opened as a result of this development.

Chromium plating of metals to give a corrosion-resisting surface has sprung into great prominence in the last few years. Unfortunately, however, the raw materials from which this metal is prepared are imported to this country because the deposits which we own are too low-grade to be of commercial interest. In order to turn these unutilized deposits into an economic asset, the Bureau of Mines, through its experiment station at Reno, is studying methods for the economic recovery of chromium from such ores.

There are in the United State millions of tons of finely divided tailings from copper concentrators which contain as much as 20 pounds of copper per ton. Some of this material has proved economically amenable to leaching with various chemicals. However, other portions are too finely divided to permit the passage of leach liquors. The Bureau of Mines, at its Southwest Experiment Station, Tucson, Ariz., has been experimenting on methods for agglomerating such material so that this difficulty may be overcome. The mechanism by which leach liquors enter rocks, dissolve the materials and are removed is likewise being studied to find the conditions under which maximum extraction can be obtained in a minimum amount of time.

Continued progress on the determination by the Pacific Experiment Station, Berkeley, Calif., of the physical chemical fundamentals of nonferrous metallurgy has resulted in the present availability of data on more than three-fourths of the metallurgically important metals and oxides.

It can thus be seen that the nonferrous metallurgical research of the Bureau of Mines is actually accomplishing the recovery of more metal from ores, developing recovery methods for deposits now considered noncommercial, and reducing costs in procedures now technically satisfactory.

PROBLEMS OF PETROLEUM INDUSTRY SOLVED THROUGH FEDERAL STUDIES

Laboratory and Field Investigations Made to Reduce Waste of Natural Gas and Oil

By H. C. Fowler,
Acting Chief Engineer, Petroleum and Natural Gas Division

The Bureau of Mines received its first Federal appropriation for work on research relating to petroleum and natural gas for the fiscal year ending June 30, 1915. However, several reports were published previously in 1913, dealing with special drilling problems and the better utilization of petroleum and natural gas. The personnel of the Petroleum Division at the time of its establishment was composed mainly of a chief petroleum technologist and one assistant.

The whole field of engineering study in the petroleum industry confronted the first members of the Petroleum Division. Upon these men rested the choice of those problems on which to direct concentrated effort in such a way that the results of study would reflect the greatest usefulness in conserving the natural resources of oil and natural gas and in addition would be broad and fundamental in character in order that all might benefit by applying the general findings to their own specific conditions. This policy has been followed without change during the following 15-1/2 years.

The initial appropriation of $25,000 for petroleum and natural gas research has been increased until the present appropriation (1930) is $232,000. For the fiscal years 1923 and 1924, however, the supervision of leases on public lands was under the direction of the Bureau, and to provide for these additional activities which were not primarily research in character the total appropriation was increased to $405,000 and $517.630, respectively, for these two years.

In addition to the recurring appropriations, four special sums amounting in total to approximately $300,000 have been appropriated for the erection and operation of an experimental oil-shale plant near Rulison, Colo. The investigation was completed and the plant closed at the end of the fiscal year 1929. The results of this special study of possible sources of supply of motor fuels, which was urged by the Navy Department, will be available shortly in printed bulletins.

Of the 88 employes in the Petroleum and Natural Gas Division, approximately 55 are technical men engaged in some phase of petroleum, natural gas, or oil-shale research.

The service rendered by a corps of consulting engineers is of outstanding importance. Their helpful advice and constructive criticism, based upon direct contact with the industry, serve to guide the technologic work toward the most useful results. These men in general are former members of the Petroleum Division who have attained national and international recognition in their special field.

The Petroleum Experiment Station at Bartlesville, Okla., in the center of the Mid-Continent area, is the largest station in the United States devoted solely to research on problems of petroleum and natural gas. The station was established in 1918 largely through the efforts of the Bartlesville Chamber of Commerce, who supplied a five-acre tract of land and $50,000 for the erection of buildings.

The State of Oklahoma has cooperated in the maintenance of the station and has gradually increased its annual appropriation for this purpose from $12,500 in 1918 to $62,500 per annum for 1930.

The engineers of the petroleum field office, Dallas, Tex., study problems of representative fields in Texas, Arkansas, and Louisiana. Particular attention is being directed to the prolific fields of the Permian Basin in West Texas.

In cooperation with the Conservation Department of the State of Louisiana, a study also of the Cotton Valley pool is being made to conserve the gas in the dome of the structure and utilize it in the production of oil on the flanks.

The petroleum field office of the Rocky Mountain district is maintained under cooperative agreement with the University of Wyoming at Laramie. The Pacific Coast petroleum field office is at San Francisco. Although the oil-shale retorting experiments have been completed, with more than 6,000 tons of shale charged through the two typical retorts at the experimental plant and an oil recovery of approximately 150,000 gallons, further study of shale-oil refining and treating methods is in progress at the Boulder oil-shale laboratory in cooperation with the State of Colorado.

In addition to administrative work, members of the Washington office answer inquiries of other bureaus, Government officials, and individuals; serve on the Technical Committee for Lubricants and Liquid Fuels of the Federal Specifications Board; and study problems relating to petroleum refining along the Atlantic seaboard and oil production in the Appalachian district.

Since the Petroleum Division was established, more than 400 technical reports have been issued on many phases of the drilling and production, the storage and transportation, the manufacture and refining, and the better utilization of petroleum and its products. Many of these publications are recognized internationally as authoritative treatises, and frequent reference is made to them in the technical literature of the petroleum industry.

It would be impractical in this resume to attempt a discussion of all the problems which are included in these publications. In general they are directed to the elimination of waste and to extending the life of the Nation's petroleum and natural gas reserves.

It should be pointed out that actual waste of petroleum, that is, loss after the oil is raised to the surface, with the exception of evaporation losses is not so outstanding a problem as devising orderly programs of development, production, and manufacture based upon sound engineering principles.

These programs include systematic "shut offs" whereby gas, oil, and water are confined to their respective strata; control of pressures in wells so as to utilize the energy of the gas associated with the oil in such a way that the greatest amount of recoverable oil will be obtained; and improvements in manufacturing technique so that higher yields and better grades of refined products will result.

That there has been a great actual wastage of natural gas in the past through allowing this valuable source of fuel and energy to escape to the atmosphere from wells is witnessed by one outstanding example which has been paralleled in many "flush" fields. Engineers have estimated that in the Cromwell, Okla., field alone the average combined initial gas production of 60 wells was over two billion cubic feet per day.

Enough gas was dissipated to the air and lost for all time during the early producing life of the Cromwell field to supply the needs of a large city for years. Not only was the actual gas lost but the energy stored in the gas was not utilized in producing oil.

In a recent study of the Bureau dealing with the function of natural gas in the production of oil, conclusions are drawn that for 1927, at least 20,000,000 barrels of oil were left in the sands of the Burbank, Okla., field, which might have been recovered with an additional revenue of approximately $36,000,000 if oil and gas had been produced under efficient pressure control over the entire field.

Another source of loss is in the transmission of natural gas. A detailed study of leakage from natural gas transmission lines has been made by engineers of the division to determine causes of leakage, methods of measurement, and methods of leakage prevention. On a number of lines tested, equivalent to 1,005 miles of three-inch line, there was before repairs were made a total annual loss of 1,099,975,000 cubic feet under average operating line pressures. This lost gas had a value of $297,000. By making reasonable repairs, which are suggested in the report, $92,000 per year would be saved on these lines alone. Since the publication of this report, the natural gas industry has adopted many of the suggestions of the Bureau of Mines regarding pipe-line leakage.

WASTE OF GAS AND OIL REDUCED BY STUDY OF PRODUCTION METHODS

Recovery of Petroleum From Wells Is Increased by Processes Developed by Federal Specialists

By H. C. Fowler,
Acting Chief Engineer, Petroleum and Natural Gas Division

General practice has been for many years to determine the open-flow capacity of gas wells by blowing them to the air. These open-flow tests are often made at regular intervals of one month.

This method not only wastes millions of cubic feet of gas annually--approximately 100,000,000 cubic feet of gas were blown to the air during one test on the Chickasha gas field, Oklahoma--but tends to interfere with gradual and uniform depletion of the sand and sometimes causes the complete loss of a well. Natural gas engineers of the Bureau of Mines have developed a fundamental basis for controlling and gauging natural gas wells which obviates the necessity of taking recurring open-flow measurements of the wells.

Demands for motor fuels continue to lead the industry to search for new sources of this necessary product. Synthetic methods for the transformation of methane gas into liquid fuels of high "anti-knock" properties have been studied by several investigators with varying degrees of success.

Experimental work at the Bartlesville station on the direct conversion of natural gas high in methane to liquid hydrocarbons has shown encouraging results, and with the technique of operation now established the study is being extended to determine the controlling factor which will result in the maximum yield of commercial motor fuel.

Studies of increasing the recovery from sands have been in progress almost since the Petroleum and Natural Gas Division was formed. The oil-recovery laboratory at the Bartlesville station has attracted visiting engineers from all parts of the world.

Many tests have been made with the view of determining what percentages of oil recovery can be obtained under different sand conditions and different methods of injecting gas, air, or other repressuring media into sands which have been partly depleted by ordinary methods of production.

Many engineers consider 20 per cent of the original oil content of the reservoir as an average figure of oil recovery by usual methods of production. What increase in recovery may be effected by repressuring methods is not yet definitely determined; but if only 1 per cent of the oil remaining in the ground were recovered by artificial stimulation, it has been estimated that the present value of this recovered oil would exceed $500,000,000.

By means of tests under controlled conditions, the Bureau is endeavoring to establish certain criteria and fundamental facts that can be applied to field practice.

The problems of storing gas in sands are closely related to those of gas injection. Engineers of the San Francisco office are studying this relatively new method of underground storage. One important point to be determined is the recoverable amount of gas after its injection into the reservoir.

The air-gas lift method of production contributed greatly to the almost phenomenal development and large daily oil production of the Greater Seminole area. This method is based on the principle of transmitting air or gas under pressure to the bottom of wells and allowing the gas to expand through a column of oil during its upward travel through the producing "string" of pipe. The density of the fluid column is decreased, thus causing the oil to flow to the surface. An experimental tower, 84 feet high, has been built at the Bartlesville station in order to study the flow of mixtures of gas and liquid in vertical pipes. Field studies pertaining to vertical flow also are in progress in the Rocky Mountains and in California where conditions are not identical with those found in the Mid-Continent.

The problems of petroleum chemistry and refining under study by the Petroleum Division are as varied as those of production. At San Francisco engineers and chemists are studying distillation methods for the removal of asphalt and sulphur compounds from California crudes. It is obvious that if removal of these impurities by fractional distillation can be accomplished, the cost of refining the products from these crudes will be greatly reduced.

At Bartlesville the Bureau has a small refinery where semi-commercial runs are made on different crudes. An outstanding development during the last year has been a fractionating tower, a unique feature being that the walls are made of glass. This allows close observation of action within the tower during fractionation.

The results of runs made with this tower are considered a valuable contribution to the technique of fractional distillation in commercial plants.

The collection of crude oil samples of the Bureau is the most inclusive ever gathered in one place. These samples have been analyzed and studied, and the results of analyses of more than 300 typical crudes have been published. This record is particularly valuable to producers and refiners as a source of information regarding the characteristics of the different crude oils of the world.

The semi-annual motor gasoline surveys made by the Petroleum Division are nationally recognized as giving a cross-sectional graph of the characteristic of motor fuels marketed in the United States.

Problems relating to sulphur in crude oils, wax and wax distillates, corrosion, evaporation losses, vacuum and its application to the recovery of oil, disposal of oil field waters, and safety in the petroleum industry are also under study.

These and others which have developed recently, such as the deviation of drill holes from the vertical and the transportation of gasoline through pipe lines, have important positions in the research program of the Petroleum and Natural Gas Division.

A partial list of future research problems of the petroleum industry shows 100 important studies on which work could be projected with definite value to the petroleum industry. This list will be augmented as new applications of science and technical knowledge are made.

It is significant that many of the engineering principles developed by the Petroleum and Natural Gas Division have been adopted by the petroleum industry with resulting diminution of losses and corresponding financial gain. To continue this usefulness as a research organization whose staff is working for the whole industry will require that future studies be undertaken with the same basic idea as that established by the first members of the Petroleum and Natural Gas Division.

The research must be broad and fundamental in nature and the findings must reflect the greatest usefulness in conserving the resources of petroleum and natural gas.

HELIUM PRODUCTION DEVELOPED AT PLANTS OF BUREAU OF MINES

New Sources of Gas Discovered and Supply Produced For Use in Inflating Airships

By Andrew Stewart,
Assistant Chief Engineer, Helium Division

Production of helium from natural gas in the United States for filling balloons and airships originated in the United States Bureau of Mines in the Spring of 1917, just after this country entered the World War.

Helium had been discovered as a constituent of natural gas in 1905 at the University of Kansas, by Professor Cady and Dr. MacFarland. It had been discovered in mineral substances by Sir William Ramsay as far back as 1895 and its properties were then studied sufficiently to demonstrate that, if it could be obtained in sufficient quantity, it would prove the ideal gas for balloons and airships on account of its extreme lightness and absolute inertness. It has 92 per cent of the lifting power of hydrogen, the lightest known gas, used for inflating airships in Europe, where they have no helium of any important amount, the United States being so far the only country in the world known to possess helium resources in sufficient quantity to admit of large-scale use of helium such as is required in aeronautics.

Up to January, 1929, Government helium production was carried on in the large production plant which was erected by the Navy and put in operation in 1921 on a Government reservation near Fort Worth, Tex. This plant passed under the jurisdiction of the Bureau of Mines by act of Congress on July 1, 1925.

However, the supply of helium-bearing gas on which this plant was operated becoming depleted, it was found necessary to close the plant down permanently on Jan. 10, 1929.

In the meantime, the Bureau of Mines, through its system of field investigations of natural gases for helium content, extending throughout the country, had located a supply of helium-bearing gas in the Cliffside Structure, in Potter County, Texas, within the great Amarillo gas field. On this structure gas rights in approximately 26,000 acres of territory have already been acquired by the Government.

In the Summer of 1928 the construction of a helium production plant was started at Amarillo. It was designed by Bureau of Mines engineers after exhaustive study and small-scale technical experimentation. The construction was carried out under contract for the Bureau of Mines and under its supervision on a site of approximately 18 acres at Soncy, a point on the Rock Island Railway about seven miles west of the City of Amarillo.

This plant was completed in the Spring of this year and has been steadily producing helium for the Army and Navy since last April. The plant is connected with gas wells on the Amarillo structure through about 12 miles of gas line, together with gathering lines. Two of these wells, already drilled, were acquired by the Bureau and two were drilled under contract with it.

Helium is being isolated from natural gas in the Amarillo plant at the remarkably low figure of about $20 per thousand cubic feet, the lowest figure at which helium has ever been produced, and further material reductions in cost are confidently anticipated. The helium is transported from the plant to point of consumption in specially designed steel tank cars owned by the Army and the Navy, in which the gas is contained under such high pressure that when released to atmospheric conditions the contents of each car expands to occupy a space of about 200,000 cubic feet.

Located on the same site with the plant is the Bureau of Mines Cryogenic, or low-temperature, Research Laboratory, in which scientific data essential to improvement of helium production and repurification processes are experimentally developed.

In this laboratory temperatures below --300 degrees Fahrenheit are reached in the various research processes. It is necessary to resort to such low temperatures in conducting the research in the Cryogenic Laboratory, since the process of isolating the helium consists in bringing the natural gas containing it under conditions of extremely low temperatures and high pressures, whereby the constituents of the gas, other than helium, are liquefied, and helium, most difficult of all gases to liquefy, is pumped off as gas.

It was in the Cryogenic Laboratory that the designs by Bureau engineers for the Amarillo helium plant, as well as for three helium repurification plants for the Army and Navy, were developed and demonstrated on a laboratory scale. Repurification plants are required to purify helium after use in airships, because through the walls of the gas cells of the ships, a certain percentage of helium continually passes out while air passes in; so that finally, by air contamination, the helium content of the ship loses buoyancy and before further use has to be purged of the air, fresh helium being added to make up losses.

In the Cryogenic Laboratory are also carried on daily control gas analyses pertaining to plant operation and analyses for helium and other constituents of samples of gas from various gas fields, in connection with the Bureau of Mines gas investigation activities in the interest of exploration and conservation of helium-bearing gas resources for the Government.

SAFETY OF MINERS IS PROMOTED BY RESEARCH ON EXPLOSIVES

Various Products Tested to Avoid Dangerous Gases And Dust Explosions in Coal Workings

By Charles E. Munroe,
Chief Explosives Chemist

The Explosives Division of the Bureau of Mines was organized primarily for the purpose of reducing or preventing coal mine explosions attending the use of explosives in mining coal and this has been accomplished by devising means of so testing explosives as to be able to distinguish, among the explosives offered, those which when used under the prescribed conditions afford the largest measure of safety, and by informing coal operators and coal miners of its findings.

Special attention is called to the phrase "used under the prescribed conditions," for both experimental investigations and experience in use have shown that strict conformity to the prescribed conditions of use is as essential to the promotion of safety as is strict conformity of the explosive in chemical constitution and physical characteristic with those of the sample tested.

An explosive which passes the prescribed schedule of tests is styled a "Permissible Explosive" and its name, together with the data obtained in the tests for its most important characteristics, is published in the "Permissible List" through which the information obtained is conveyed to coal mine officials, coal miners, and all who may desire it.

For various reasons, such as the development of new explosives, or the improvement in older explosives, or the drafting of new permissible requirements, and other causes, from time to time new explosives are added to the Permissible List or older explosives are removed from it. Hence to keep users and manufacturers fully informed a Permissible List is issued annually, the first of July, announcing all the explosives then on the list, and on the first of each other month of the year, if any changes have been made during the preceding month, a supplementary list is published setting forth the nature of the changes.

The Bureau of Mines does not feel that in its endeavor to secure safety in mining coal it is restricted solely to the study of substances classified as explosives and it has therefore within the past 18 months devoted much time and effort to the study of liquefied carbon dioxide as a blasting agent for use in coal mines with the result that one device charged with this material has passed all the required tests and been placed on the Permissible List.

Hence we have it today that that gas which causes the effervescence in "soda water," that gas which extinguishes flame promptly, that gas which in its solid form is extensively used as a refrigerant under the name of "dry ice." is now used in its compressed and liquefied form in several coal mines in this country to blast down the coal.

Although permissible explosives are especially designed for use in coal mines, they may be and are used, or at least some of them, in other industries, such as metal mining, quarrying, and engineering operations, and to this extent these last mentioned industries benefit in full from the investigations and tests made by the Explosives Division.

This arises from the fact that in the development of coal mines a large variety of blasting work is encountered, for not only is coal to be blasted, but to reach the coal, shafts must be sunk, tunnels must be driven, and other mining work done which is largely carried out in rock or earth and this requires for use explosives of different characteristics from those used in blasting coal, but since in the carrying out of this work about coal mines inflammable gases or coal dust may be encountered the explosives used, though quite unsuitable for blasting coal, must yet possess the "permissible" qualifications. Hence an examination of a July Permissible List will show it to comprise explosives having widely differing characteristics but all agreeing in that each and every one of them had passed the tests of being shot into explosive mixtures of inflammable gas and air; and of coal dust and air; and gas, coal dust and air, without causing the explosion of any of these explosive mixtures in galleries in which the tests were carried out.

From the beginning of the work of testing explosives, in 1908, as carried on by this Division, it has been recognized that there was much about explosives that was unknown, yet to secure the safest and most efficient explosive for a given use one should possess the most intimate knowledge of all its characteristics and the effects of environment upon them, and most especially their behaviors towards other explosives and explosive atmospheres such as may be encountered in practice. It is obvious that information such as this can be obtained only through experimental inquiry. Hence researches have been conducted side by side with the routine testing from the outset.

A direct outcome of these researches has been shown in the successive revisions of the Schedule of Procedure for Testing Explosives for Permissibility for Use in Coal Mines whereby, while increasing the severity of the tests, the cost of conducting them and the time required have been materially reduced.

The results of another research published under the title of "The Effect of Stemming on the Efficiency of Explosives" proved of especial value to the metal mining industry as attested by reports from large operations, and that, when the stock of governmental copies of the report was exhausted, it was reprinted in full by permission and widely circulated by private parties at their own expense.

Another report that was viewed with approval by the mining profession was entitled "Effect of Cartridge Diameter on the Strength and Sensitiveness of Certain High Explosives," as it taught how greater certainty of propagation of the explosive reaction could be secured in practice from which greater efficiency, economy, and safety in use were insured.

In 1908 little consideration was given to the products resulting from the firing of explosives and their effect on the atmosphere of the mines in which they were fired but this was early given consideration and has continued a constant problem with the division.

It has been shown that explosives may be made to produce poisonous gases to pollute the atmosphere of the mine, and inflammable gases to form explosive mixtures in the mine. The Division's researches have shown that, from this standpoint, the paper in which the explosive is wrapped to form the convenient cartridges in common use plays a part.

While this problem is by no means completely solved because of the difficulty of collecting true samples underground and the difficulty of simulating mine conditions in laboratory apparatus, yet checks are applied and manufacturers are so compounding their explosives as to produce the minimum of noxious and inflammable gases.

These examples are but a few from the many investigations which have been and now are being conducted by the Explosives Division of the United States Bureau of Mines.

EXPERIMENTAL MINE IS MAINTAINED FOR STUDY OF ACCIDENT PREVENTION

Research Conducted on Causes of Explosions and on Improved Methods of Ventilation

By George S. Rice,
Chief Mining Engineer

The Experimental Mine is a unique mine, since it is laid out like a commercial mine and in it tests are carried out on a large scale. It was opened at a carefully selected point in an outcrop of the Pittsburgh coal bed, about 13 miles from Pittsburgh, near Bruceton, Pa., soon after the Bureau of Mines was established in 1910.

It enabled the Bureau of Mines to assert positively and demonstrate before thousands of mining men that coal-dust explosions were possible without the presence of gas, under mining conditions. It enabled the Bureau to take the lead in determining beyond question the principal factors that enter into coal-dust explosions and those of gas and dust, and to affirm in 1913, as the first official agency of any country to go on record, that rock-dusting was a positive means of limiting or preventing explosions of coal-dust in mines.

The effects of the presence of methane or "gas" upon inflammations of coal-dust and results of the gas explosions without dust under mining conditions are studied. In these studies of explosions it was vital to obtain records of pressures and velocity of pressure waves and of the flame to be automatically recorded. Velocities are registered to one-thousandth of a second, and pressure from below atmospheric pressure up to several hundred pounds per square inch may be registered.

A cable containing 33 wires runs into the mine to the different places to obtain various kinds of records. This cable is placed and concreted in a channel along one side of each entry and passes through various junction boxes and explosion-protection chambers in which the instruments are placed.

The relative explosibility of coal dusts from mines located in various coal fields of the country is determined for the respective mine operators so as to enable them to take appropriate precautions and use definite proportions of rock-dust, supplemented as secondary defenses by such rock-dust barriers that have been tested in the experimental mine and found successful in stopping explosions. Generalized rock-dusting prevents any coal-dust explosions from starting.

The mine is used for various kinds of testing, for example, methods and apparatus for extinguishing mine fires, the construction of explosion-proof stoppings, and methods of using explosives. Guniting the roof or walls of both metal mines and coal mines, now so extensively used to prevent weathering and flaking of the roof, was first employed underground in the experimental mine in 1913 and its effectiveness demonstrated under many conditions of roof or mine walls, if done promptly when the tunnels or entries are being driven.

The ventilation method to be used in the New York-New Jersey vehicular tunnel and also in the Oakland-Alameda tunnel was first tried out in an elliptical trackway especially constructed in the experimental mine, the method being to force the air in below the floor of the roadway, the exhaust being drawn off by suction fans above the ceiling of the roadway, giving a cross or transverse ventilation rather than a longitudinal ventilation and disposing immediately of the carbon monoxide given off by gasoline-propelled vehicles and providing safety from smoke fumes in case of collision and fire.

Ten automobiles were used in these tests and these were run around and around on the trackway. Careful physiological studies were made of the effects on drivers and passengers in the cars, and in this way safe limits for the permissible percentage of carbon monoxide was determined.

Mine ventilation studies have been carried on in the experimental mine to determine the coefficients of friction of air currents in mine passages, including the friction of line-brattices, effects of curtains, of turns or bends in the passageway, the presence of mine cars and other restrictions of the area.

At the present time studies are being carried on to determine the extent of recirculation of air and gases in using auxiliary fans in headings and to determine the proper placing and arrangement of such fans and tubing, that is, when and where it is advisable to use them.

During the war an improved geophone was developed at the experimental mine, and since then studies in radio wave transmission through the walls of natural strata have been studied.

Educationally, the mine has been of great value, not only in demonstrations of those matters above mentioned and others, but it has been also used by State mine inspection departments to examine the ability of candidates for State mine inspectorships, in determining the presence of gas, of dangerous amounts of coal-dust, and of defects in electrical wiring as prearranged by the examiner.

The British Department of Mines and the United States Bureau of Mines are actively cooperating in their efforts to prevent accidents in mines by conducting joint research on causes of mine accidents and appliances and methods for their prevention.

This cooperation is an unusual one in the history of international relations. There have been many cooperations other than of a political character between countries, such as standardization projects, and temporary cooperation as regards weather and oceanic matters, but so far as is known this is the first official international continuing cooperation on a research program.

This cooperation was entered into in 1924, receiving official sanction of the respective departments of the two governments. It deals with problems of the relative explosibility of different coal dusts and mine gases, investigations of electrical machinery and apparatus and explosives, development of new testing apparatus in several investigations, the standardizing of new routine tests of mine electrical apparatus and other mining machines, coal-mine explosives, prevention of accidents from falls of roof and coal, and other subjects which which relate to the safety and health of miners.

The advantages of such cooperative investigations of individual countries are to hasten the obtaining of scientific data in the saving of life and limb by the prompt interchange of information, the avoidance of unnecessary duplication, and on the other hand to compare scientific results arrived at by different methods, different procedure, and different instruments, so as to provide checks on the accuracy of the data obtained.

To further this, from funds appropriated, respectively, by Congress and the British Government, there is an annual interchange of research personnel. The results have already been highly beneficial in the inspirational effects upon the staffs by the visits of British research men to testing laboratories and mines in the United States, and Bureau of Mines research men to Great Britain, and in obtaining the knowledge of the leading specialists, respectively, in the two countries. A series of publications have been issued by the Bureau and the British Mines Department and in technical literature, giving the results of the researches.

One of the principal functions of the cooperative work described above, as already indicated, is to aid both the British and American mining bureaus in formulating the fundamental principles of safety for the guidance of operators and miners in the operation of mines.

In the United States Bureau of Mines, a special board has been established, known as the Mine Safety Board, whose particular function is to weigh safety proposals and formulate basic recommendations. The work of the Safety Board, therefore, while it is a Bureau institution for the solving of mine safety problems of the mining industry of the United States, extends beyond this field and has a close relation to the cooperative studies mentioned above, for the basic recommendations which the British Government studies with a view to application in British mines are largely confirmed by decisions of this board.

The Mine Safety Board of the Bureau was established to consider questions of the Bureau's policy on technical matters relating to safety, and its decisions, when approved by the Director, represent the policy or opinion of the Bureau of Mines on the particular question relating to safety. All complicated questions or those in which there is a wide divergence of opinion are weighed carefully before any decision is reached as the basis for teaching and policy of the Bureau.

CURRENT INFORMATION PROVIDED ON CONDITIONS IN COAL INDUSTRY

Bureau of Mines Compiles and Disseminates Data on Production, Marketing, and Consumption

By O. P. White,
Head of the Coal Division

The coal industry ranks as one of the greatest in the country in the value of its resources, production, and in the number of men employed. As the chief source of energy, the coal resources of the country are the foundation of the industrial and commercial development in which the United States leads the world, and in the long run the stability and prosperity of industry in general are dependent upon sound and prosperous conditions in the coal industry.

In available resources of coal the United States possesses about 51 per cent of the world's total and its annual output is approximately 40 per cent of the world's production.

The position of the coal industry in the economic structure of the country calls for an adequate and continuous program of fundamental data regarding its various phases, for the guidance of producers, distributors, and consumers in meeting current conditions and planning future operations.

With the voluntary cooperation of the industry, the Coal Division of the Bureau of Mines now supplies much of the necessary economic data and plans to enlarge the scope and usefulness of this work as the needs and demands of the industry develop and funds can be provided.

In order to consolidate within the Bureau of Mines, so far as practicable, all the Department's work in the economics of coal, the Coal Division of the Bureau of Foreign and Domestic Commerce, excepting employes engaged directly in foreign trade promotion, was transferred to the Bureau of Mines on Jan. 1, 1926, and it has since taken over the work of gathering, compiling and publishing statistics of the coal and coke industries, which functions were formerly exercised in the United States Geological Survey directly under the Division of Mineral Resources and Statistics.

The Coal Division makes studies and furnished information to the Government, the industry, and to the public of the economic conditions and problems of the coal industry of the United States, including a number of products of coal. Its work is carried on with funds provided in the annual appropriation for the "economics of the mineral industries." This work relates to the industrial and commercial economics of coal, as distinguished from the scientific and technical problems of the industry, and is concerned with the domestic phases of the industries covering coal and coal products.

The scope of the Division's work includes, among other things, the uses of coal, reserves, prices, production, distribution, consumption, stocks and marketing. This involves the duty of keeping abreast of current conditions and development of all branches of the industry from all reliable sources available.

In this particular, the knowledge of current conditions and developments in the domestic industry must be supplemented by similar knowledge of general economic and trade conditions in foreign countries which are among the suppliers of the world's coal markets or which are potential customers for American coal.

A section of the Coal Division is engaged in the collection, compilation, analysis, and dissemination of statistical data relating to the coal and coke industries. Such data cover primarily information concerning production, distribution, stocks, and consumption of coal and coke.

The statistical data gathered by the Coal Division are published in a weekly coal report, a monthly coke report, and by special reports and correspondence. A survey of the commercial stocks of coal on hand is made quarterly and the data distributed in the form of a special mimeograph report. Annual summaries of the economic data collected by the Bureau are published in separate bulletins covering coal, coke and by-products, and fuel briquets, which are later incorporated in the annual volumes on mineral resources.

The Coal Division publishes monthly a general survey of conditions in the domestic industry, covering the producing fields, the tidewater markets, and important retail markets. This survey is made up of reports from leading representatives of producing and marketing branches of the industry and gives an authentic picture of the situation in the industry at the end of each month.

The Division is also called on to furnish the other departments of the Government information as to current conditions, markets, and prices in the coal trade, and acts as adviser for certain services in the matter of purchases of coal supplies.

An important unit of the Coal Division is the Government Fuel Yards, which purchases coal and distributes it to all Federal and District Government buildings and establishments in the District of Columbia (with the single exception of the Washington Navy Yard), as well as those institutions just outside the District which can be supplied economically through this organization.

The maintenance of this service involves the operation of a large receiving, handling, and storage plant with the necessary fleet of motor trucks and personnel. During the fiscal year ended June 30, 1929, approximately 239,000 gross tons of coal (231,000 tons of bituminous and 8,000 tons of anthracite) were distributed to about 550 points.

STATISTICS OF MINERAL INDUSTRY COMPILED FOR GUIDANCE OF TRADE

Figures Prepared by Bureau of Mines on Output, Consumption, and Stocks, and on Accidents to Employes

By Frank J. Katz,
Chief Engineer, Division of Mineral Statistics

The Division of Mineral Statistics collects and prepares, for use and publication, statistical information for the Government, mineral industries, and the public, relating to (1) the production and value of minerals; (2) the causes of accidents to men engaged in the production of minerals.

The statistics of the production and value of minerals relate to (a) quantity and value of production, annually and in part monthly or weekly, of essential mineral commodities; (b) consumption, distribution, stocks, prices, and uses, in part annually and in part monthly, of selected mineral commodities; (c) supplemental statistical compilations of domestic imports and exports of minerals and the production of minerals in foreign countries.

The statistics of accidents to men engaged in the production of minerals relate to (a) monthly and annual statistics of fatal accidents in coal mines; (b) annual statistics of fatal and nonfatal accidents covering all principal mineral industries (except coal mines, petroleum wells, and steel mills); (c) annual statistics of accidents at several hundred typical mines and quarries which are participants in an annual safety contest conducted by the division.

In addition to its mineral commodity and accident statistics, the division collects and publishes monthly and annual statistics on the consumption of explosives. It may be stated, incidentally, that mines and quarries consume about three-fourths of the 500,000,000 pounds of industrial explosives used in the United States annually.

As a by-product of its statistical activities, a large volume of information has been accumulated and an important function of the division is responding to letters and oral inquiries relating to the sources and uses of mineral products, to employment and safety in mining, and to miscellaneous matters connected with the production of and traffic in minerals.

It may be of interest to state that the annual output of minerals in the United States is valued at approximately $6,000,000,000 and that about 1,000,000 men are employed in the industry, of whom about 2,200 are killed and 200,000 are injured by accidents each year.

The principal activities of the division lead to two series of publications:

(1) "Mineral Resources of the United States," an annual collection of approximately 50 chapters, each dealing in detail with a mineral commodity or distinct group of commodities, and 16 State or regional chapters dealing with

metal mining, together with an introductory and summary chapter presenting statistical material on the mineral products of the United States and by States.

(2) A series of annual and monthly reports relating to mine accidents and the consumption of explosives.

The work of the division also yields a series of preliminary reports issued in mimeographed form, the object of which is to give early publicity to the results of the various canvasses and to issue currently weekly statistics on coal and coke and give monthly statistics of Portland cement.

In the preparation of some of the annual reports included in the "Mineral Resources of the United States," the division makes use of the specialized knowledge of the technical employes of the other division of the Economic Branch of the Bureau for the purpose of supplementing and illuminating the statistical material by authoritative discussion of economic and technologic advances and trends within the industry, and to put in the hands of users authoritative data on the sources of supply, uses, and the economic importance of the various mineral commodities.

The annual reports included in the "Mineral Resources of the United States" also contain special data on imports and exports which are recompilations of data originally assembled by the Bureau of Foreign and Domestic Commerce, and also, so far as available, statistics on the production of minerals in foreign countries.

The purpose of these supplementary features is to give readers of the reports a complete picture, especially of those minerals in which foreign activity affects domestic production and consumption.

In the conduct of its work the division maintains close cooperative relations with other agencies of the Federal Government and the State governments and also with various associations. Within the Federal Government the division's principal cooperative activities include joint statistical effort with the Bureau of the Census within the field of those industries which have both a mining and a manufacturing aspect, for example, metallurgy and petroleum refining.

The division contributes to the Bureau of Foreign and Domestic Commerce material for that Bureau's publications "The Statistical Abstract" and "The Commerce Yearbook."

With some institutions cooperative activities are of two kinds: (1) In the collection of production statistics, by formal cooperative agreements, the conduct of the canvass is placed in the hands of this division in order to avoid duplication of effort, the State organizations furnishing assistance. Approximately 16 States have, for many years, cooperated in this way.

(2) In connection with some of the accident statistics work, under formal and informal agreement, State mine inspection services and State compensation commissions make available to the Mine Accident Statistics Section of this division data which were originally collected by them.

ECONOMIC DATA ON OIL INDUSTRY PROVIDED BY FEDERAL SURVEYS

Distribution and Methods of Utilization of Petroleum and Its Products Studied by Bureau of Mines

By E. B. Swanson,
Acting Chief Economist, Petroleum Economics Division

A stove manufacturer, whose principal market was in the central United States, wanted to know whether he should continue to make stoves which would burn coal and the extent to which he should make allowance for the increasing use of natural gas and oil-burning equipment.

A large steel plant on the Atlantic Coast now using oil as fuel wanted information regarding the present fuel oil supply in order to determine whether or not their furnaces should be converted to coal-burning. A manufacturer of cereals, whose product is wrapped in waxed paper, wanted information on the production, stocks and demand of paraffine wax, in order to estimate probable price trends.

These are samples from the daily run of questions submitted to the Division of Petroleum Economics, Bureau of Mines.

In addition to questions of this type, there are the numerous requests for specific data on petroleum production, here and in foreign countries, inquiries regarding the production and uses of petroleum, coke, natural rock asphalts, technical naphthas and other products, lists of petroleum refineries, and similar data.

The Petroleum Economics Division makes statistical and economic studies relating to the petroleum, natural gas, and allied industries. The work of the division falls under five major headings: The manner in which the products of petroleum refineries are used; the movement of petroleum and its products from producing to consuming areas; statistical reports of production, stocks, and consumption; the assembly of economic data pertinent to the petroleum industry; and certain types of foreign studies.

The first of a series of studies on the uses of petroleum products is now being completed. This is "Petroleum Coke--An Economic Survey of its Production and Uses." Similar surveys covering other petroleum products, such as paraffin wax and special asphalts, are planned.

Studies of distribution are made to determine the extent to which certain consuming areas depend upon other producing areas for their supply of petroleum products. Annual surveys of this sort are published covering the Atlantic and Pacific coasts. A "National Survey of Fuel Oil Distribution" gives information on the annual consumption of fuel oil by industries and States.

The principal statistical report issued is the monthly petroleum statement, which contains current information on the production, stocks and consumption of crude oil, natural gasoline, motor fuel, fuel oil, wax and other petroleum products. It is issued approximately 30 days after the close of each month and certain selected statistical items are telegraphed to the Bureau's office at San Francisco, Calif., Bartlesville, Okla., and Dallas, Tex., where they are released simultaneously with the distribution from Washington.

The broad interest in this statement is shown by the diversity of interests represented on the mailing list, which includes producers and marketers of petroleum products, traffic and fuel officers of railroads, economics and statistical research organizations, telephone and other public utilities, banks and financial houses, public and private libraries, tire and rubber companies, manufacturers of waxed paper and paper products, and consumers of gas oil or fuel oil, such as the manufacturers of chemicals, manufactured gas, stoves and heating appliances, food products, cement, zinc and iron and steel products.

Purchasing agents and other officials of such companies need to keep in touch with trends in the petroleum industry in order to forecast the probabilities of future supply and conditions under which oil may be available. The geographical distribution is indicated by the fact that the report is mailed monthly to 22 countries, either directly or through local representatives. Approximately 2,000 business houses receive this report monthly.

In addition to this monthly statement, special annual reports are issued on crude petroleum, refined products, natural gas, natural gasoline, asphalt and related bitumens, and carbon black. These reports present final figures.

The annual report on natural gas contains the only complete data available on its production, distribution, and consumption. A constant demand for information on this subject has resulted in numerous recommendations that similar data be collected and published at more frequent intervals.

The division has kept in touch with petroleum production and economic developments in foreign countries, principally through governmental agencies and periodical publications. A complete review of world oil production was prepared and published as an Appendix C of Report III of the Federal Oil Compensation Board, entitled "Petroleum Resources in Foreign Countries and Outlying Possessions of the United States."

Through the cooperation of the Bureau of Foreign and Domestic Commerce, the Department of State, and various private oil companies and associations, representative samples of crude petroleum from various fields in the eastern hemisphere are being assembled. These will be analyzed at the Bartlesville, Okla., experiment station and the results of these analyses, together with pertinent economic data, will be issued jointly by this division and the Petroleum and Natural Gas Division of the Technical Branch.

Although the Petroleum Economics Division was not established as a separate unit of the Bureau until 1925, its statistical data on the production of crude oil go back 70 years to the drilling of the Drake well; monthly reports on the operation of petroleum refineries are available beginning with the last six months of 1916; and the studies of distribution are available only since 1926.

USES DEVELOPED FOR RARE METALS AND FOR NONMETALLIC MINERALS

Division of Bureau of Mines Studies Production Methods and Assists in Promoting Industry

By Paul M. Tyler,
Acting Chief Engineer, Rare Metals and nonmetals Division

The Rare Metals and nonmetals Division was organized Dec. 1, 1927. As its name implies, the work of the Division deals with the less common and rare metals and with the nonmetallic minerals other than coal, oil, and gas.

While it is not within the province of the Bureau of Mines to make analysis for the use of private individuals or corporations, the Division receives annually approximately 1,000 specimens of various kinds. All but a few of these specimens can be identified by means of visual examination or simple tests and reports are made, therefore, as to the identity and commercial possibilities of most of the minerals sent in.

In many cases names of possible buyers are given, and in case the samples or the accompanying letter make it appear worth while, a form letter is sent out requesting further information with regard to the size, location, and extent of development of the deposits.

The Division has succeeded in a great many cases in bringing buyer and seller together to their mutual advantage. New uses are constantly being found that enlarge the demand for first one and then another of the so-called "rare" elements. On the other hand, there are numerous deposits that lie idle because the owners lack knowledge as to how or where to find a market for the minerals contained therein.

In order to keep step with the rapidly changing aspects of these industries, the Division endeavors to keep up-to-date lists of possible buyers, producers, and dealers for each of the numerous and diversified mineral commodities which come within its field.

In many instances it is necessary first to compile a list of potential uses and then to develop by correspondence lists of firms that actually are in the market.

Information with regard to prospects and non-commercial deposits is kept on file and indexed for ready reference and notes are made of accessory minerals found in deposits operated for the production of other minerals. Questionnaires were sent to producers of feldspar and mica, for example, asking them with regard to the presence of beryl in their deposits.

During the past year 260 lists of possible buyers and 240 lists of producers were furnished in response to requests for market information.

Most of the general industrial surveys conducted by the Division are summarized in the various chapters in the Bureau's volumes of Mineral Resources of the United States, and in information circulars and economic papers. Among the special studies completed, or practically completed, during the past year, were those relating to graphite, gypsum, ocher, strontium compounds, clay, cadmium, and mineral wool.

A report entitled the "Economics of new sand and gravel developments" was prepared during the year and sent to the printer.

Cost studies of quarry operations in the crushed stone and cement industries are being carried on with a view of determining standard average costs for unit operations where conditions are comparable, such figures to serve as guides in attaining more efficient operations. Similar studies are being made of the slate industry.

Other special studies are being made into the economics of phosphate rock, barite, slate, granite, asbestos, and other nonmetallics.

A study of the mica deposits of the United States and the general conditions affecting our domestic mica industry was undertaken in November, 1928, in cooperation with the War Department.

Examinations were made of many of the mica deposits in Maine, New Hampshire, Connecticut, New Mexico, South Dakota, the Carolinas, Georgia, Alabama, and Virginia. Calls were made upon most of the leading manufacturers of mica products and upon the principal importers and dealers in connection with a market study of foreign and domestic micas.

Perhaps the outstanding development in the investigation to date is the fact that it is now possible to prepare mica splittings in this country by means of a machine. Formerly these splittings could be produced only by hand and the work could be done only in such low labor cost countries as India.

This discovery, since it will afford a ready market for small mica at three or four times the price now obtained for the same material as scrap or punch mica, may make it possible to operate profitably many mines that otherwise could not pay expenses and this in turn may result in a greater output of large mica as well as in a growing national independence as regards splittings.

While it has not been possible with the time and funds available to examine all the domestic deposits, the investigation has demonstrated that the mica resources of the United States are vastly greater than had hitherto been believed.

The Rare Metals and nonmetals Division has on display an educational exhibit of economic minerals and their products which has proven of great interest to visitors to the Washington office. Specimens have been received from all sections of the United States and various foreign sources.

A novel feature of the exhibit is a collection of balls or spheres of the various metals. Another interesting feature is a collection of radioactive minerals assembled from Africa, Czechoslovakia, Cornwall, Russia, Brazil, Canada, Ceylon, and other foreign countries as well as from domestic deposits; a number of undescribed new minerals are included. From time to time portions of the exhibit are loaned to other organizations.

In order to improve facilities for identifying and determining the commercial possibilities of mineral specimens sent in by prospectors and owners of deposits, the Division has equipped a small chemical laboratory and installed a new petrographic laboratory for preparing polished sections and thin sections.

RECORD OF OUTPUT AND RESOURCES OF METALS IS KEPT TO AID INDUSTRY

Statistics Compiled and Correlated to Give View of General Conditions in Mining Business

By C. E. Julihn,
Chief Engineer, Common Metals Division

The work of the Common Metals Division of the Bureau of Mines had small beginnings shortly after the termination of the Civil War, when there arose a demand for more precise information regarding the mineral resources of our Far West.

In 1866 the Secretary of the Treasury, in response to a request of Congress, instructed J. Ross Brown to study and report upon mineral resources in the States and territories west of the Rocky Mountains. A preliminary report was soon made and the final report was transmitted to the Speaker of the House of Representatives in 1868.

Two years later Rossiter W. Raymond, as Commissioner of Mining Statistics, continued this work with a report entitled "Statistics of Mines and Mining in the States and Territories West of the Rocky Mountains." This was repeated annually for about a decade in response to an exceedingly active public interest in mining.

Responsibility for the continuance of such records was then assigned to the United States Geological Survey upon its establishment and the first volume of "Mineral Resources of the United States" was published in 1883. To this series of annual volumes we are indebted for the possession of a more complete official record of the national production of minerals and metals up to the present time, as the publication has been continued by the Bureau of Mines since this work was transferred to it from the Geological Survey in 1925.

The transfer brought to the Bureau of Mines the statistical force of the Geological Survey, but not its technical staff, whose members had contributed valuable part-time service in the preparation of "Mineral Resources of the United States" as specialists in the economics of metals and minerals.

Four divisions were accordingly established in the economics Branch of the Bureau of Mines to cooperate with the Division of Statistics in the preparation of the "Mineral Resources" volumes and to specialize in economic studies regarding the mineral industries. One of the new divisions is the Common Metals Division.

Its field includes the economic aspects of copper, lead, zinc, tin, aluminum, nickel, iron, manganese, chrome, gold, silver, pyrite, and sulphur. The small group of specialists in the division write or are responsible for the "Mineral Resources" chapters on the metals and other mineral commodities mentioned above. The division has also developed extensive files and indexes covering published data upon them. These data are used in answering numerous inquiries from other Government agencies, the public and the mineral and metal industries.

They are also used extensively in the study of economic problems related to the common metals and in the preparation of economic papers that render the results obtained available to the public.

Typical of such work is the series of economic papers on the production of the common metals, copper, zinc, and lead, and others on gold, silver and tin. These papers summarize production of the stated metals from 1800 to the present, bringing together in a single table the production of the continents and all producing countries for various periods. They make possible a grasp of the facts of production which had not been obtainable previously.

Shorter periods have been fragmentally covered for individual countries or groups of countries, but in attempting to bring the records together the individual was confronted by various units and the records were not generally available except in large technical libraries.

The service rendered industry was therefore a systematic review of sources of information, the selection of what was deemed the most authoritative data, the conversion of figures to a single unit and the orderly arrangement of the material to render the salient features of production apparent.

This service is such as was referred to in the first issue of a new technical journal (Metal and Alloys, July, 1929, Vol. 1, No. 1, p. 1): "When the Engineering Foundation recently asked some 50 iron and steel metallurgists what was the greatest service that could be done to the iron and steel industry, they were unanimous in stating that even more important than the finding of new facts was the compilation and correlation of those facts already on record but largely unappreciated and unused."

There has thus been added to the primary work upon the "Mineral Resources" volumes an almost equally important endeavor to render available to industry much fundamental data that is constantly asked for in vain.

The next series looked forward to as a by-product of the primary work of the division will be one on the known reserves and probable ultimate resources of the common metals throughout the world. A considerable amount of data for this project has been collected already and when it has been carefully digested and rendered available it should be of enormous value to industry in reckoning its course for the future.

HEALTH OF WORKERS IN MINES PROMOTED BY FEDERAL SERVICE

Problems of Gases and Dusts Are Studied and Surveys Made of Physical Condition of Employes

By R. R. Sayers,
Chief Surgeon

In carrying out its work, the Health Division of the Bureau of Mines is subdivided into a Field Section and a Laboratory Section, which work in close cooperation and share a mutual interest in many of the problems undertaken. Whenever it is deemed advisable laboratory personnel are detailed to the field or field personnel are brought into the laboratory and in this manner problems and needs of the industry are dealt with by each section contributing the effort and information it is best fitted to give.

The work of the Field Section is carried on in cooperation with the United States Public Health Service, the medical personnel being detailed to the Bureau of Mines by that service, and in certain cases with mining organizations and other agencies interested in industrial hygiene.

From time to time the general information gained by these studies is incorporated in publications. Through the medium of these publications the causes of undesirable conditions as well as the methods which have been found most satisfactory in combating them are disseminated to the mining industry.

At the time of making these investigations observations are made of the medical organizations and industrial hygiene. Reports dealing with these phases are also prepared and recommendations made for the improvement of existing conditions, or for the installation of efficient medical organizations and methods of hygiene where they are lacking.

In addition to general sanitary survey work the Field Section conducts investigations relative to the effects of gases and dusts on the health of the workman.

In 1926 an agreement was entered into by the Bureau of Mines, the Metropolitan Life Insurance Company, and the Tri-State Zinc and Lead Ore Producers Association (composed of mine operators of the three States of Kansas, Oklahoma, and Missouri) for the purpose of expanding the clinic already in operation by the Bureau of Mines at Picher, Okla., to afford facilities for examining each workman in the district at least once a year to determine the effects, if any, of the conditions under which they work on the health of the miners.

A building adequate for the work has been constructed and equipped and is now in use. About 9,000 examinations of men and 500 of women and children are made each year. A large amount of similar data has been secured previously from the coal and iron mines of Alabama, the lead-zinc mines of Oklahoma, and the gold mines of Nevada and California.

The causes of death among miners in the principal mining districts of the United States are being studied for the purpose of ascertaining the diseases and types of accidents most prevalent among miners with the object of instituting preventive measures. So far, data have been collected from the records of the States of Alabama, Indiana, Nevada, Illinois, California, Arizona, Colorado, Utah and Wyoming.

The Laboratory Section of the Health Division conducts research work pertinent to the toxic limits and physiological effects of gases, as carbon monoxide, hydrogen sulphide, sulphur dioxide, etc., as well as devises apparatus and methods for their detection. Some of the laboratory and field studies which have been recently completed are the physiological effects of long exposures to low concentrations of carbon monoxide such as would be encountered in mines where the air would be slightly contaminated with mine fire gases, "after damp" from explosions, inadequate ventilation after blasting, or in automobile garages, vehicular tunnels, around blast furnaces, and many other places in the industries.

This work supplements previous work done in connection with the ventilation of the Liberty vehicular tunnels, Pittsburgh, Pa., which are now in use, and the Holland tunnels, New York City, which were opened early in November, 1927.

Other major work conducted by the Laboratory Section has dealt with the health hazards in the use of ethyl gasoline, the toxic gases given off in the handling and refining of high sulphur crude oil; hydrogen sulphide poisoning in oil fields, in tunnels, and in caisson work; and the use of helium-oxygen mixtures instead of air for deep diving and work under high pressure; also extensive investigations have been carried out on the physiological effects of abnormal temperatures and humidities.

The Laboratory Section is subdivided into laboratory units, each dealing with a more or less special phase of health research, as Gas Analysis Laboratory, Gas Masks and Respirators Laboratory, Pathological and Physiological Laboratory, and Stream Pollution Laboratory.

The Gas Laboratory is a specialized central laboratory for the purpose of analyzing and examining gas samples collected in mines throughout the country by the Bureau of Mines field engineers and frequently by State mine departments and works operators in connection with health and safety studies.

These samples comprise atmospheres taken during: (1) Studies relative to improvement of ventilation in mines; (2) from sealed mine fire areas to determine the progress of the fire, as the composition of the gas gives an indication when the fire is out and the area is safe to enter and recover; (3) samples taken in connection with rescue and recovery work after explosions in order to safeguard the health and safety of the rescue workers; and (4) the development, testing and approval of mine equipment when gas-air mediums are required to ascertain the safety of their use in potentially gassy atmospheres.

In cases of emergency, as mine explosions and mine fires where life and property are endangered, personnel are detailed from the laboratory to give assistance in their particular field of work. This service is also extended in many cases to State mine departments and to mine operators.

The Gas Masks and Respirators Laboratory investigates the use and suitability of industrial masks and respirators for encountering atmospheres containing toxic and deleterious industrial gases and dusts such as occur in mines and metallurgical plants, leaks from refrigerating machines, during fire fighting by municipal fire departments or in mines, railroad tunnels, etc.

One of the principal duties is to make careful tests of commercial masks submitted by the manufacturer. If the appliance equals or exceeds certain test requirements, the manufacturer is granted an approval plate which he is permitted to display on his product, thereby giving the consumer a certification of its quality. If the device fails to meet the requirements the manufacturer is advised and given recommendations for improvement.

A development of this laboratory is an apparatus that will continuously record the amount of carbon monoxide in the air of mines, tunnels, commercial garages, etc. A number of these were installed in the Holland tunnels, New York City, for the purpose of safeguarding the health and safety of the public and also as a control for the ventilation system. This device has other uses, as in the testing of household gas appliances and investigative work dealing with carbon monoxide poisoning.

Another accomplishment of importance to industrial hygiene has been the development of a readily portable and efficient apparatus for the collecting of atmospheric dust samples which serve as a basis for evaluating health hazards as well as testing the efficiency of devices and procedures for allaying or preventing the formation of dusty atmospheres. This latter is of outstanding importance in metal mines and stone quarries as a mitigation of silicosis and in coal mines as a preventive measure against disastrous coal dust explosions.

The Pathological and Physiological Laboratory usually works in conjunction with the other laboratories and with the Field Section in conducting studies and researches dealing with the physiological effects and pathological changes attending exposure to air containing various gases and dusts of known or unknown toxic action and effect on health.

In addition to this, specific studies are undertaken on the pathology of carbon monoxide poisoning, pathological changes attending exposure to various gases, vapors, and dusts found in the industries, an important one of which is a study of the action of mineral dusts with special reference to the occurrence of silicosis. This has a practical application in the testing of inert rock dusts with which the workings of many mines are now periodically coated to render the coal dust nonexplosive lest in the zeal of preventing coal dust explosions another health hazard will be incurred.

The Stream Pollution Laboratory is primarily engaged in studying the factors underlying the formation of acid mine drainage, its amount and possible means of disposal. To this end surveys are made of the character and amount of acid water given off by mines in certain districts and its influence on the local streams.

In these, the examination starts at the source of formation in different parts of the mine and is then followed out until it issues as a stream or is pumped from the mine. Particular attention is given to the potential acid-forming constituents throughout the course of the water, and after the drainage enters fresh water streams its dissipation is observed.

The information obtained by the Health Division as a whole is disseminated to the industry and the public through the medium of Government publications, the technical press, and in a large measure by correspondence and personal contact.

SAFETY IN MINING IS FOSTERED BY INSTRUCTION OF WORKMEN

Employes Advised of Proper Practices and Shown Methods of First-aid Treatment of Injured

By Daniel Harrington,
Chief Engineer, Safety Division

One of the underlying reasons for the origin of the United States Bureau of Mines was the desire to promote greater safety in mining and allied industries. Safety continues to be an important feature in the work of the Bureau and during the fiscal year 1929-30 out of a total Bureau of Mines appropriation of $2,249,670 (other than for helium) the amount allotted the Safety Division is $387,510.

The Safety Division personnel consists of 22 engineers, 2 mine safety commissioners, 2 senior foreman miners, 20 foreman miners, 16 first-aid miners, 16 clerks, 10 cooks and 4 laborers, a total of 91. These safety workers are distributed through the 10 districts into which the United States has been divided for administration purposes.

The 10 all-steel mine rescue cars have headquarters as follows: Car 1, Berkeley, Calif.; Car 2, Raton, N. Mex.; Car 3, Pittsburgh, Pa.; Car 4, Terre Haute, Ind.; Car 5, Pineville, Ky.; Car 6, Pittsburg, Kans.; Car 7, Huntington, W. Va.; Car 8, Duluth, Minn.; Car 9, Butte, Mont.; Car 10, Des Moines, Iowa. There is also a mine rescue car with headquarters at Juneau, Alaska. In addition, there have been established 11 mine rescue stations as follows: Birmingham, Ala.; Berkeley, Calif.; Seattle, Wash.; Evansville, Ind.; Jellico, Tenn.; McAlester, Okla.; Norton, Va.; Vincennes, Ind.; Wilkes Barre, Pa.; and Pittsburgh, Pa.

Each of these mine rescue stations has a full complement of equipment and devices for use in case of a mine fire or explosion and at each station is an up-to-date automobile truck. At time of a mine disaster the Bureau's forces are immediately placed at the disposal of the authorities, State or company, with a view to giving such assistance as may be desired or available.

The activities of the Safety Division at ordinary times are directed largely to securing and disseminating data on safety in mining. Among the numerous studies made, or being made, concerning safety and health in mining are those in connection with the causes and methods of prevention of mine explosions, explosibility of dust and gases, explosives and blasting, haulage, electricity, falls of persons or material, ventilation, dusts, high temperatures, timbering, machinery, and in fact practically anything which results or may result in accidents of any kind in or around mines.

One of the main features of the work of the field forces of the Safety Division is the giving of instruction in methods of first aid to the injured and of the use of various kinds of mine rescue apparatus. During the fiscal year ended June 30, 1929, 82,563 full courses were given in mine rescue and first aid to those employed in mining and allied industries, this being by far the greatest number for any one year, the best previous year being 1928 when 48,604 full courses were given.

At present this type of work is at the height of its popularity as employers are now realizing that if all employes are given this training, especially that of first aid to the injured, the employe simultaneously gets safety training and becomes, or at least tends to become, "safety minded." The employer no longer depends wholly upon the Bureau of Mines forces to do all of the first-aid training and the increased interest by the employers is seen in the rapid growth in the past few years of cooperative training in which the employer aids the Bureau forces in training in first aid; in the fiscal year ending June 30, 1927, the number cooperatively trained was about 9,000, which was by far the best record up to that time; in the year ending June 30, 1928, those cooperatively trained in first aid numbered over 20,000 while those cooperatively trained in first aid during the fiscal year ending June 30, 1929, numbered nearly 31,000.

Since its establishment the safety forces of the Bureau have trained upwards of 375,000 persons in the mining and allied industries in the full first aid and mine rescue courses, 172,045 having been given the training during the past three years; in addition several thousand persons outside of the mining and allied industries but living in or near mining localities have taken all or a part of the courses. As a direct result of this training it is conservatively estimated that at least 200 lives are saved annually.

A special or advanced course of instruction for mine officials in directing rescue or recovery work in case of mine disaster requiring about a two weeks' period of instruction was given in full to 727 persons during the fiscal year ending June 30, 1929, this course having been given to 736 in the year ending June 30, 1928, and to 457 in the year ending June 30, 1927. Much effort has been expended in the preparation of a course of instruction in safety in coal mining and it is expected to have this course ready for use before Jan. 1, 1930. Similar courses will be preapred for metal mining and for the petroleum industry.

As a part of the work of the Safety Division in the forwarding of the first aid and mine rescue training much time and effort are expended in connection with first aid and mine rescue meets; in fact most of the attention of the field men of the division is centered on these meets during June, July, August, and September of every year.

The demand for the services of the Safety Division personnel for various activities for these meets is such that at times it is impossible to fill all of the requests for aid. During the last fiscal year the Bureau safety men assisted actively at 94 meets at which 1,541 teams involving 9,246 persons participated as principals; during the previous year there was participation in 46 meets.

As a culmination of these local meets there is annually held an International First Aid and Mine Rescue Meet which is sponsored by the Bureau of Mines. The International Meet was held in Butte, Mont., during the fiscal year ending June 30, 1929, and one was held on Sept. 12, 13, and 14, 1929, at Kansas

City, Mo., there being in competition 49 teams from 18 States representing not only the coal and metal mining industries but also sulphur mining, fluorspar mining, steel and ore smelters, the petroleum industry, and the cement industry.

In addition to other duties the field men, more especially the engineers, make underground mine examinations and reports not only at time of mine disaster but also at ordinary periods, these reports in general giving a description of conditions as to safety and usually with specific suggestions as to feasible methods towards increasing safety. Most of the reports of this description are not published but some of them are transmitted confidentially to the mine operator.

During the past fiscal year over 300 safety reports of various kinds (compared with 165 in the previous year) were made or handled by members of the Safety Division, and of these 27 formal reports on mine disasters were transmitted confidentially to mine operators, 40 formal safety examination reports were also sent confidentially to the operators and 50 papers on safety subjects were published by the Bureau of Mines or by the Technical Press or in the proceedings of technical societies.

The number of manuscripts prepared for publication by members of the Safety Division increases rapidly: There were 50 papers by members of the Safety Division published in the fiscal year ending June 30, 1929, against 29 such manuscripts during the fiscal year ending June 30, 1928, and 12 in the fiscal year ending June 30, 1927. During the fiscal year ending June 30, 1929, the Bureau's attention was called in one form or other to 38 mine explosions involving 139 fatalities, 24 mine fires involving 4 fatalities, and 17 miscellaneous mine accidents with 35 fatalities, the total involving 79 accidents or disasters with 178 killed.

The record of the year was much better as to explosions than the record of the previous year, there having been but 139 fatalities in the 38 explosions during the fiscal year ending June 30, 1928, against 342 killed in 31 such affairs during the previous fiscal year.

INFORMATION ON SAFE PRACTICES DISTRIBUTED TO MINE OPERATORS

State Inspectors Advised of Findings of Bureau of Mines on Protection of Workers in Industry

By Daniel Harrington,
Chief Engineer, Safety Division

In order to secure maximum effectiveness for the data on safety subjects published by the Bureau of Mines there have been prepared lists of mining men known to be sufficiently interested in mine safety to read literature on that subject; as soon as new safety data are published, the data are transmitted to the persons on the lists, care being taken to send only such data as are likely to interest the recipient; in other words, coal mining data in general are sent only to coal mining men and metal mining data only to metal mining men.

The State inspectors are placed on special lists and each State inspector is sent the Bureau's latest safety literature at his home as soon as the data are available. The effect of this direct contact policy on Bureau safety literature is reflected in much closer cooperation with the Bureau's safety work not only by the mining operators but also by the State inspection forces in nearly every State in the Union.

The industry is inclined to offer much better financial inducements to expert safety workers than can be given for similar work within the Bureau and as a consequence the turnover among the approximately 60 field engineers and other field men of the Safety Division is high. During the year, 19 new men (engineers and first-aid miners) were taken into the Safety Division. As it requires at least two years before these new men are fully assimilated into the Bureau work and functioning even approximately well, this situation at times seriously handicaps the progress of current work. The new men are now given a course of instruction of several months at the Pittsburgh Station and this materially expedites their availability for general field work.

The loss of safety men to the industry has numerous advantages to the Safety Division even though it also entails some handicaps: Each of these Bureau men who goes into the industry remains essentially a Bureau worker inasmuch as he continues to spread safety doctrine essentially along Bureau of Mines principles.

During the past year a large amount of safety work has been done in cooperation with State mine inspection forces in Alabama, California, Colorado, Illinois, Kentucky, Maryland, North Carolina, Utah, West Virginia, and other States. Four newly appointed electrical inspectors for the State of Pennsylvania were conducted through the safety and experiment station at Pittsburgh and given information as to the Bureau permissibility system and to the Bureau's ideas in regard to the hazards connected with the use of electricity in mines.

The Safety Division is also carrying on a study of explosives accidents in Pennsylvania in cooperation with the State Department of Mines, and cooperativ investigations and reports were made on serious mine disasters. Cars 1 and 7 were engaged in an intensive campaign of 100 per cent first-aid training in the State of West Virginia in cooperation with the State Inspection Department, training having been given in 78 communities in West Virginia during the past year. An engineer of the Safety Division was assigned to Kentucky to make safety inspections of the coal mines of Kentucky in cooperation with the various State inspectors. A similar arrangement was perfected in Utah.

An inspection and report were made of treated timbers in a mine in Michigan in cooperation with the University of Wisconsin and the Forest Products Laboratory of the Department of Agriculture.

In Illinois, Alabama, Indiana, Colorado, and other States the inspection force of the State assisted materially in forwarding the complete or 100 per cent training of the personnel of mining companies in methods of first aid to the injured. In North Carolina, California, and other States, the Bureau upon request of State officials, cooperated with State officials in giving suggestions as to safety in mines or in industries affiliated with mining.

One of the most notable of the cooperative activities of the Safety Division during the year was that in which many of the field men of the Safety Division throughout the country assisted the Portland Cement Association in its no-lost-time accident drive, this assistance being in the form of giving the Bureau's first-aid course to several thousand employes of the cement industry, and also the Bureau's engineers participated in a considerable number of safety meetings of the Portland Cement Association and gave talks and suggestions on safety. The cement industry is making noteworthy strides towards elimination of accidents.

One of the most extensive of the cooperative activities of the Bureau is that of guiding the Joseph A. Holmes Safety Association and the Holmes safety chapters. At the annual meeting of the Joseph A. Holmes Safety Association on Mar. 5, 1929, there were awarded five gold medals, three silver medals and 26 diplomas to persons engaged in mining for heroic services performed. There were also awarded nine certificates of honor to companies and two to individuals for meritorious safety records.

The Safety Division made arrangements for the presentation of these certificates and medals, in most cases the presentation being made at a public gathering. It is estimated that the full time and effort of at least three persons are expended yearly in sending representatives to make these presentations, in furnishing speakers at the chapter meetings, and other miscellaneous activities connected with this work. A monthly mimeographed publication is issued known as the Holmes Chapter Notes, this publication giving approximately 5,000 words monthly on various phases of safety work both outside of and within the Holmes Chapters. At the present time there are 70 active chapters in the Holmes Safety Association, the purpose of which is to promote the safety, health, and welfare of miners and their families.

When it is considered how vast is the extent of the activities of the mining industry, including coal and metal mines, quarries, and the oil industry, it is soon realized that a personnel of 91 is decidedly small to cover all of the ramifications which affect or are affected by safety in the industry; nevertheless, much has been accomplished in this field.

INFORMATION ON EFFICIENT MINING GIVEN IN FEDERAL PUBLICATIONS

Results of Research on Safety and Economy in Industry Distributed in Pamphlets and Letters

By John A. Davis,
Chief Engineer, Information Division

The Information Division of the Bureau of Mines edits and distributes publications describing the results of the Bureau's investigations conducted with a view to promoting health, safety, and efficiency in the mineral industries; it summarizes the Bureau's findings to make them available to the technical, trade and daily press; it prepares and conducts exhibits for conventions of technical societies and for expositions; it answers thousands of letters requesting information about the wide diversity of matters pertaining to the field of Bureau activities; and it supervises the preparation and circulation of motion-picture films depicting technologic and safety methods or processes used in the mineral and allied industries.

In the 19 years since its establishment, the Bureau of Mines has issued 835 different printed publications. Of these, 300 are bulletins presenting in comprehensive and permanent form the results of scientific investigations; 450 are technical papers giving similar results but in briefer and more tentative form; 4 are economic papers giving analytical studies of production statistics, sources, resources, distribution, and industrial flow of mineral commodities; 36 are miners' circulars dealing with the prevention of mine accidents, first-aid and mine rescue methods, and health and sanitation, and are written in popular style for the men actually engaged in mining; 18 are annual reports of the Director, summarizing the work of each fiscal year; 8 are safety handbooks and charts; and 19 are schedules outlining the procedures for testing explosives, mine lamps, breathing apparatus, mining machinery and mine equipment with a view to determining from a safety point of view the "permissibility" of these items for use in mines.

The Bureau has also issued annually since 1925 approximately 60 reports containing statistical information concerning the preparation and consumption of mineral materials.

These separate reports are combined later in two complete annual volumes of "Mineral Resources of the United States."

Each year, approximately 75 mimeographed or multigraphed Reports of Investigations are issued by the Bureau. The purpose of these brief papers is to present promptly to the industry the summarized results of work which may be described more fully later in bulletins or technical papers.

The Bureau also issues annually approximately the same number of mimeographed or multigraphed Information Circulars. These present technical and safety information which it is thought should be made available to the mining industry but which does not necessarily represent the result of original investigations by the Bureau of Mines.

When new publications are ready for issuance, descriptive postcard notices are prepared by the Information Division and mailed to all who have expressed the desire to receive them. Descriptive lists of Reports of Investigations and Information Circulars are also mailed to a separate, smaller list.

At the same time a condensed statement summarizing the results and conclusions given in the publication are prepared and released to the technical, trade, and daily press by which they are extensively used.

Similar statements for the press are also prepared and issued at the conclusion of outstanding investigations by Bureau engineers and before publications giving the full details are ready for issuance, thus making the findings promptly available to the public.

Exhibits illustrating various phases of Bureau work--such, for example, as the use of gas masks, the dangers of hydrogen sulphide, the value of rock dusting to prevent mine explosions--are prepared by the Information Division for conventions or expositions of scientific societies and manufacturers' or producers' associations, and for county or State fairs.

The Bureau of Mines serves the million miners and quarrymen of the United States, the million or so workers in the metallurgical and petroleum industries, and other large groups. Its studies of the efficient utilization of fuels are of direct interest to every manufacturer and power-plant operator, to the boiler-plant fireman, and even to the operator of the small domestic heating furnace.

Investigations regarding the use of explosives in mining are equally valuable to the man who uses explosives in building roads or the blowing up of stumps.

Research in internal-combustion engine fuels is of interest to the millions of owners of automobiles. Various bulletins on smoke prevention are applied for by those interested in civic betterment. The Bureau's investigations looking toward more healthful and more sanitary conditions in the mining camps are equally adaptable to the needs of non-mining communities. Statistical reports on production and consumption of different mineral materials are greatly valued by commercial and financial interests.

The Bureau's research in the development of mine rescue oxygen-breathing apparatus has resulted in the designing of respirators and gas masks which have been of value to city firemen, railway train crews, workers in chemical industries, and many others whose daily labors expose them to dangerous smoke and fume conditions.

With its work appealing to such an extensive and varied audience, the Bureau naturally is the recipient of a large number of letters requesting information and publications. In some years, more than 100,000 of such letters of inquiry, touching upon almost every conceivable matter of interest to the mineral and allied industries, have been received.

Although it is the Bureau's policy to refer to its specialists inquiries of a highly specialized and technical nature in the majority of cases the Information Division is able to save the time and energy of these specialists by answering the more general inquiries.

The Bureau of Mines has a large collection of educational industrial motion-picture films which show different steps in the production, treatment, and utilization of the essential mineral materials or illustrate safe methods of mining and preparing minerals. The films are produced through the cooperation of industrial concerns, which defray their cost; but the supervision of production and the circulation of these films come within the jurisdiction of the Information Division.

On June 30, 1929, the collection contained 563 sets of films, comprising 1,486 reels, each approximately 1,000 feet in length. During the past year the films were shown on 9,100 occasions before an estimated attendance of 2,375,000 persons. Circulation is centered at the Pittsburgh Experiment Station of the Bureau, with 16 sub-distribution points throughout the country. The films are loaned to schools, churches and clubs, civic, business and military organizations, miners' local unions, and other interested bodies, without cost other than for transportation.

MACHINERY IN MINES IS TESTED TO INSURE SAFETY OF WORKMEN

Efficiency in Utilization of Fuels Is Fostered by Research at Bureau of Mines

By Rudolph Kudlich,
Acting Chief Engineer, Mechanical Division

The Mechanical Division of the Bureau of Mines operates under two appropriations, one, the Investigation of Mine Accidents, and the other, Testing Fuels. Its various activities naturally group themselves under two classifications, that having to do with mining machinery, and that with investigations into the quality and use of fuels.

The work on mining machinery is confined primarily to the safety side of the subject, studying mechanical and electrical equipment used in mines from the standpoint of lessening the hazards which their use incurs to the personnel of the mine.

About the time the Bureau of Mines was organized the use of electricity in mines was making rapid strides. There was some question in the minds of some as to whether the economies which the use of electricity effected were sufficient to warrant the extra hazard which the widespread use of electricity incurred.

This became one of the first problems which the Bureau attacked. Studies were made of the ignition of gases and coal dust by sparks and arcs from electrical machinery, which showed that electrical machinery, if properly constructed, could be used with impunity in places where gaseous mixtures might occur.

An approval system was built up under which electrical machinery and devices are submitted under schedules which specify the minimum requirements necessary, in the opinion of the Bureau and other interested parties, to prevent the ignition of surrounding atmospheres by electrical sparks produced in the machine.

Schedules have been published from time to time covering tests of electrical machinery used underground to mine, load, and transport the coal, electric and flame lamps used for illumination and devices for detecting the presence of dangerous accumulations of gas. Machinery and devices for practically every purpose necessary inside of a coal mine have passed such tests and are available to the mine operator so that he can equip his mine with machinery which will practically eliminate the danger of explosions from that source.

In addition to the routine testing of machinery submitted for approval as "permissible," the Electrical Section conducts research work in the field of ignition of gases by electricity, the prevention of propagation of flames and similar phenomena which have a bearing on the design of electrical apparatus for use in mines.

The actual mechanical hazards were better understood by mining men and machinery manufacturers, so that the need did not arise for the establishment of an approval system as it did with the electrical machinery, and the Bureau's work along these lines has not been so extensive. The Mechanical Section interests itself principally in hoisting and haulage machinery and safety devices used with such equipment.

The greater volume of work is done in connection with the testing of fuels. This phase of the work covers both routine service in determining the quality of fuels and their use and scientific studies to determine fundamental chemical and physical principles in the combustion and utilization of fuels.

It covers service to Federal departments, State, and municipal organizations, investigations into the use of fuels, and research on carbonization of fuels and by-products obtained from carbonization, synthesis of fuels, constitution of solid fuels, and miscellaneous chemical analyses which may be of materials worked with in any of the above mentioned investigations, or of solid or liquid substances met with in the other activities of the Bureau. That part of the fuels work having to do with service and use of fuels is carried on under the supervision of fuel engineers and chemists, while the research work is supervised by the chief chemist of the Bureau.

As service to other Government bodies, assistance is given in preparing specifications, awarding contracts and sampling deliveries of coal and, at the coal analysis laboratory, analyses are made of these samples as well as others collected in the course of other investigations both by the Bureau and other Government agencies.

Another class of service is rendered by the Fuel Economy Service Section. This section acts in the capacity of consulting engineer to various Federal departments in matters related to the efficient use of fuels in heating and power plants both as to the design of new installations or alterations to old plants and as to the operation of existing plants.

The investigations on the use of fuels are carried on both with respect to their combustion in furnaces of various types and to their conversion into manufactured gas. Both the basic principles of combustion and their practical application to power plant and domestic boiler furnaces and certain other furnaces are studied.

Experiments and tests on the combustion of coal both on grates and in powdered form have developed data which are of great value to manufacturers and operators of boiler and heating furnaces.

Information obtained on the relative efficiency of combustion which can readily be attained with different fuels assists the central station operator, the manufacturer who maintains an isolated power plant, and the domestic user of coal. Studies of the fusibility of ash from coal yield information which is of assistance in overcoming clinker troubles in some furnaces and removing the ash in others.

Changes in supplies of gas-making fuels and in market conditions both as to material required for the manufacture of gas and the disposal of the produc bring about changes in gas-making methods. As such changes occur in certain districts, experiments are made, usually at operating plants, to determine how these changing conditions can best be met.

The research work serves to determine the fundamental facts on which practices in the use of fuels may be based. At the present time, interests in future developments in the use of fuels turns to carbonization and the synthesis of liquid fuels from the more readily available solid hydrocarbons. Typical American coals are treated by various carbonization methods to ascertain how they respond to such treatment and what by-products are obtained. These by-products are also studied as to their characteristics and the manner in which they can best be utilized.

A method is being developed for testing coal in the laboratory to ascertain its carbonizing characteristics and the yield of coke, gas, and by-products which can be obtained in practice. The synthetic production of light hydrocarbon liquid fuels from gases obtained at least in part from coal is being given considerable attention. The catalytic effect of various substances on the chemical reaction involved is being studied. Microscopic examination of coals disclose information on its constitution and origin which is of value in studying carbonization, ease of ignition, and in correlating different deposits.

In addition to routine work of analyzing miscellaneous materials which are submitted by other investigating groups of the Bureau, a certain amount of experimental and research work is done in connection with the development of standard methods and apparatus for testing solid fuels of mineral origin.

In an organization having so wide a field of activity as the Bureau of Mines, there is a certain amount of overlapping of the work of the different divisions. Hence the various sections and laboratories of the Mechanical Division from time to time assist other divisions and at other times receive assistance from them both in experimental or testing work and by consultation.